Energy Efficient Buildings for High Tech Industries - An Integrated R&D and Market Transformation Program

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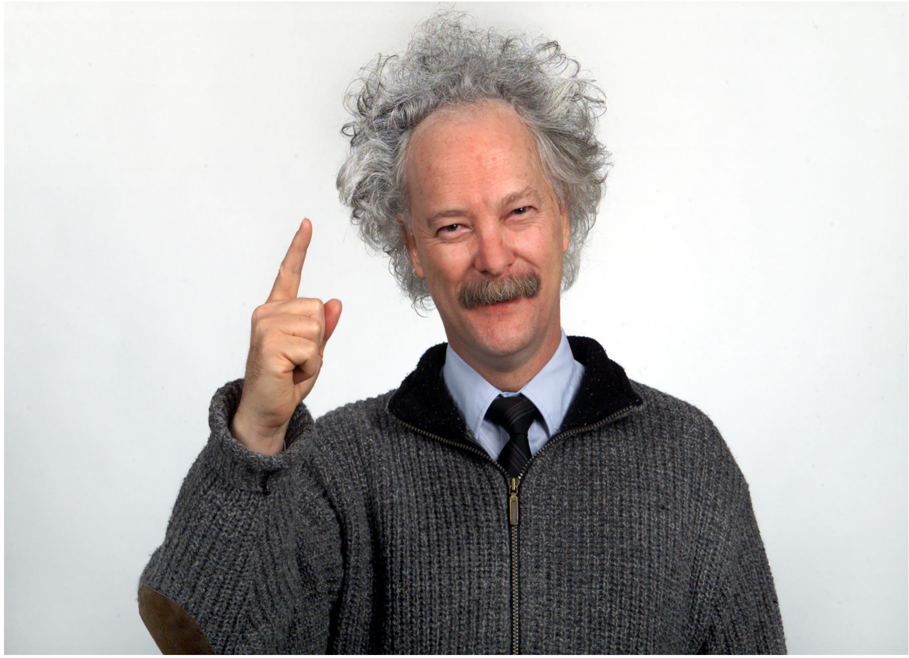


What Is The Applications Team?

Diverse Group from LBNL

Research Staff

+

In-House Energy Management

=

A-Team

A-Team

Energy Efficient Design Applications

http://ateam.lbl.gov

Why The High-Tech Buildings Sector?

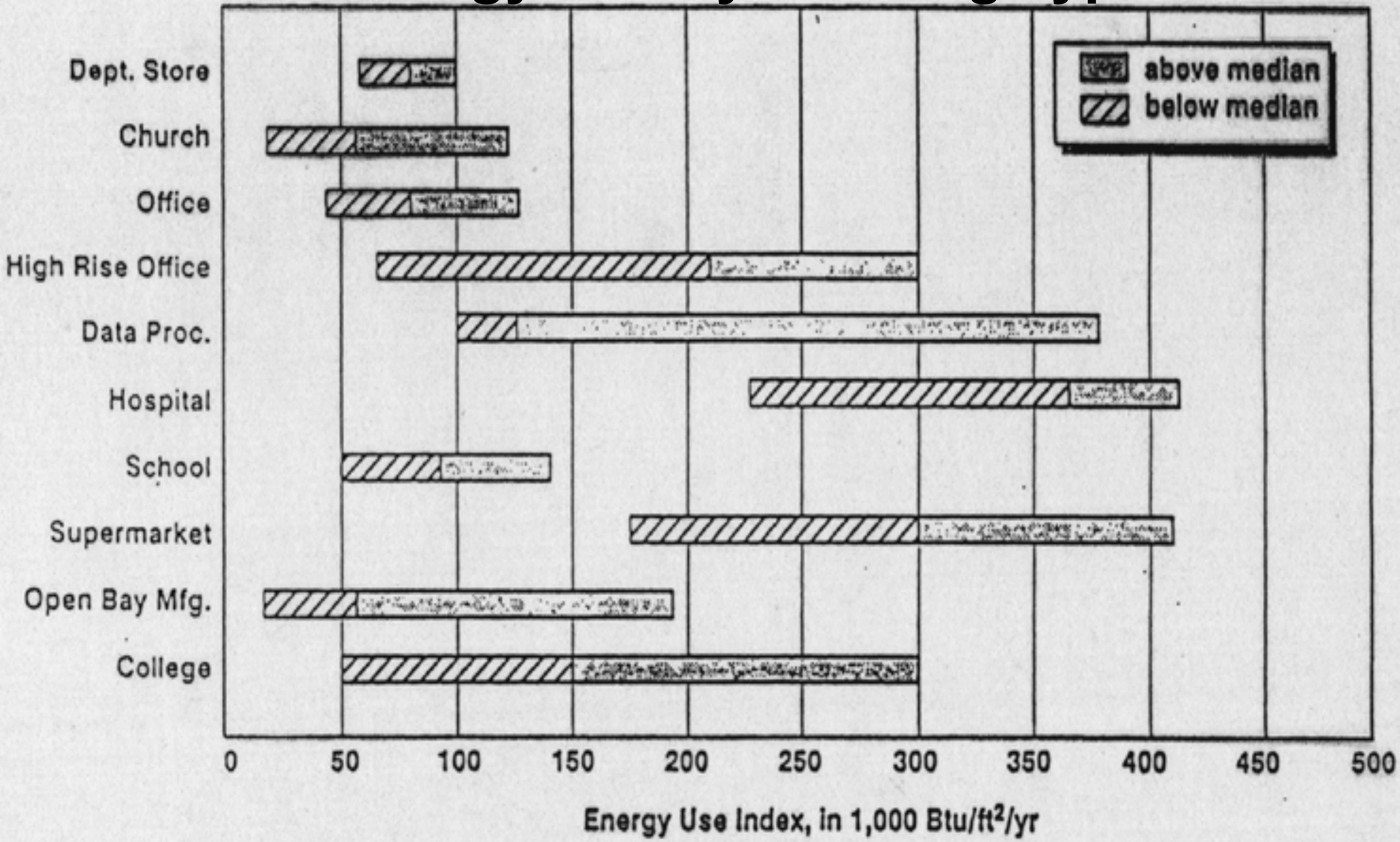
Laboratories, cleanrooms, and data centers
…serve industries of the future

Unique environmental needs
…very energy intensive

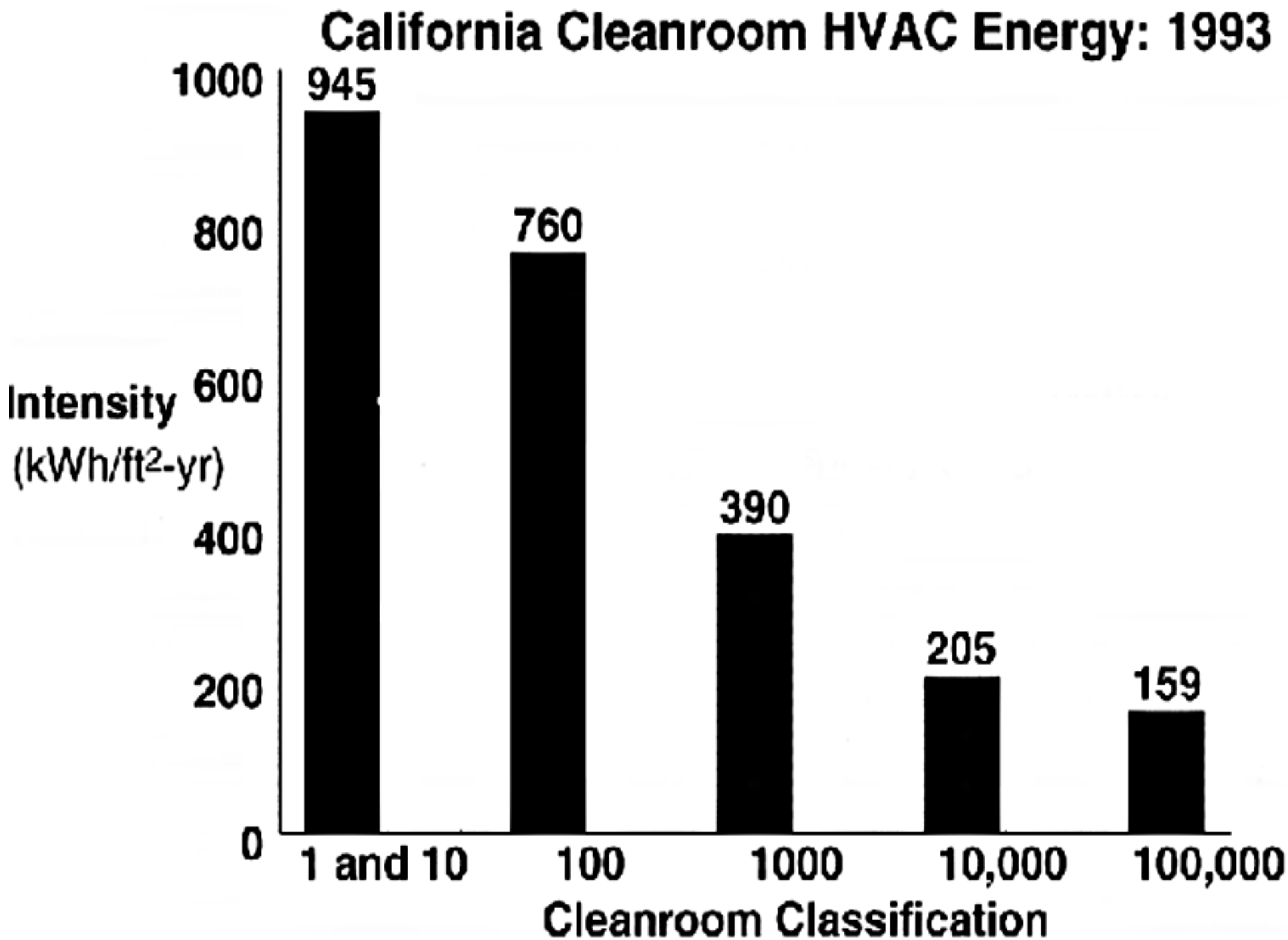
Significant efficiency improvement opportunities *...1 billion therms/year, 40 billion kWh/year, 10 GW*

…new construction: 2 therms/sf, 90 kWh/sf, 20 W/SF

Energy Use by Building Type



Source: Washington State Energy Office, Olympia, WA

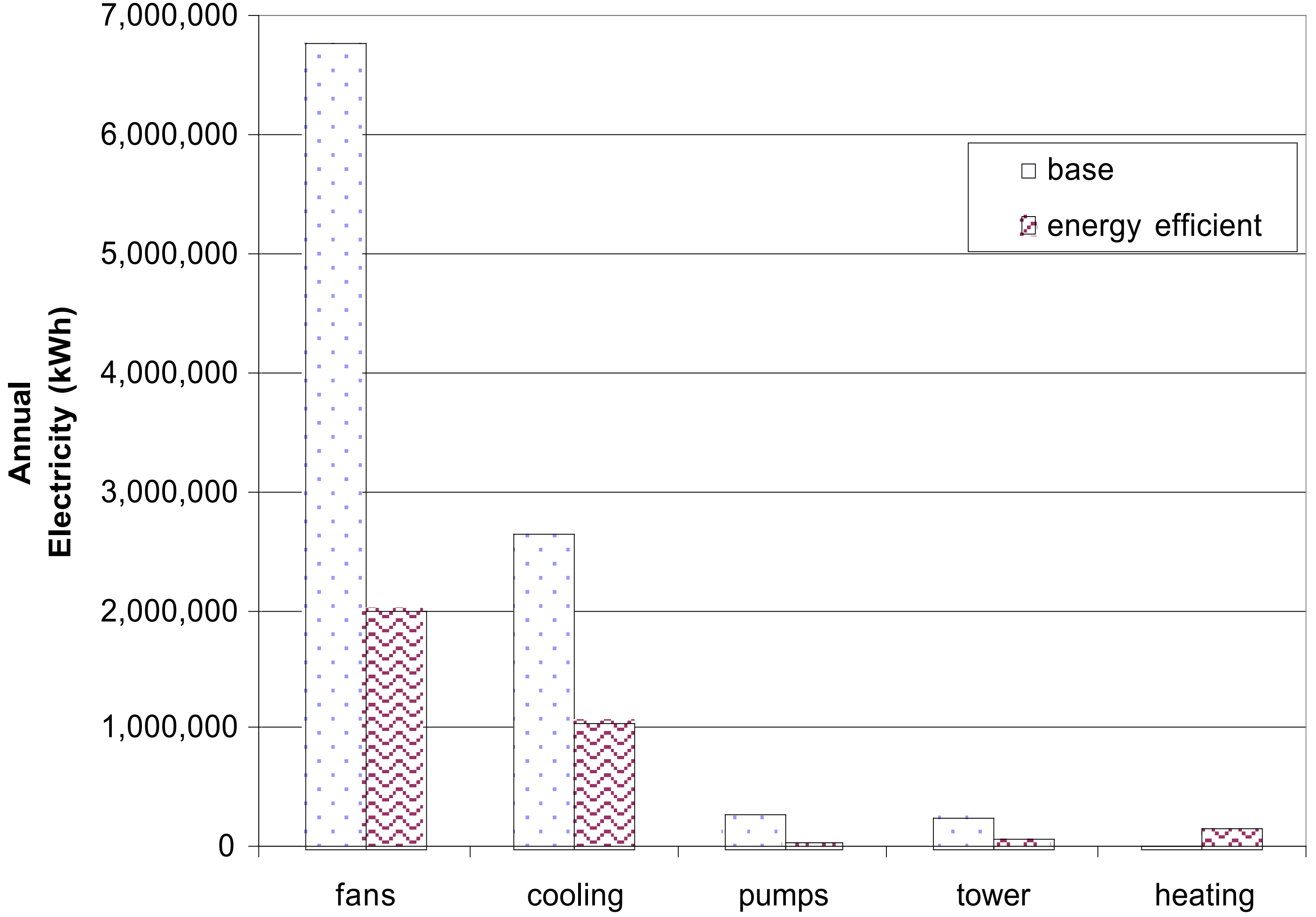

California Cleanroom HVAC Energy: 1993
Intensity
(kWh/ft2-yr)
1000
800
600
400
200
0
945
760
390
205
159
1 and 10
100
1000
10,000
100,000
Cleanroom Classification

States with the Largest Number of Cleanrooms

- California
- New York
- Texas
- Ohio
- Illinois

Opportunities are Significant

Cleanroom End-Use Energy Breakdowns



Opportunities Are Real
LBNL Example:

- 40% reduction in energy use per square foot from 1985 baseline
- $4 million/year more research based on 1985 energy prices
- Improved worker productivity
- Safer environment
- Improved reliability

LBNL Leads an Integrated R&D and Market Transformation Initiative

High-Tech Buildings Initiative Sponsors:

- *Pacific Gas & Electric Co.*
- *San Diego Gas and Electric Co.*
- *California Institute for Energy Efficiency*
- *California Energy Commission*
- *Montana State University*
- *Department of Energy (BTS and FEMP)*
- *Environmental Protection Agency*
- *Northwest Energy Efficiency Alliance*
- *New York State Energy Research & Development Authority*
- *Private Industry (Organizations and Companies)*

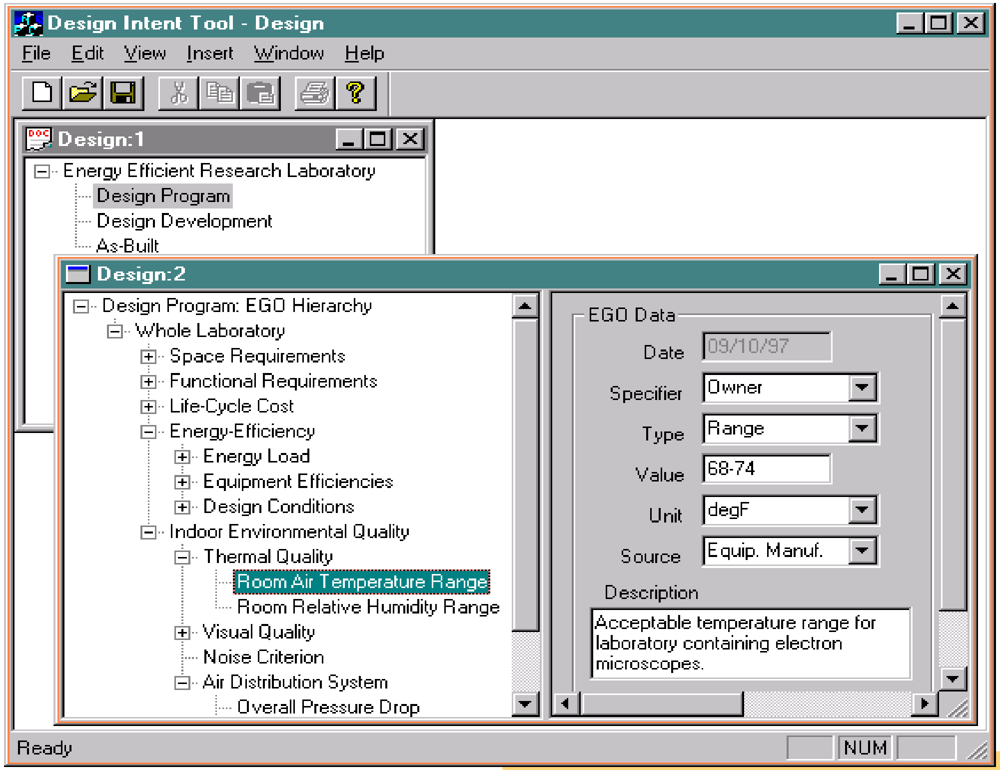
Representative Initiatives

- Information Technology – Design Intent Tool
- Benchmarking Protocols and Tools
- High Performance Fume Hood
- Labs for the 21st Century Tool Kit

Information Technology: Design Intent Documentation Tool

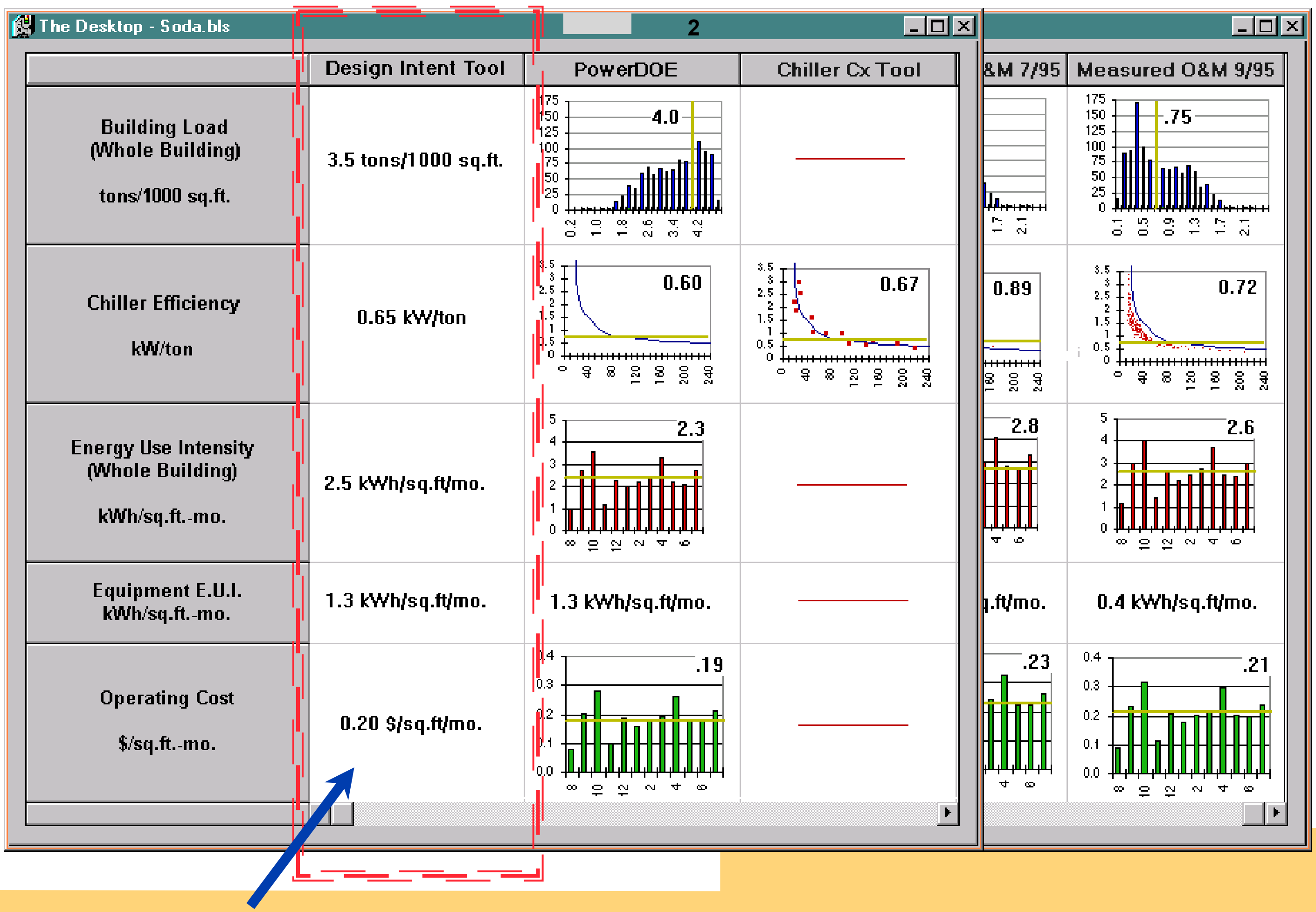
Objective:

Capture design intent information & performance expectations for use throughout the building's life-cycle.

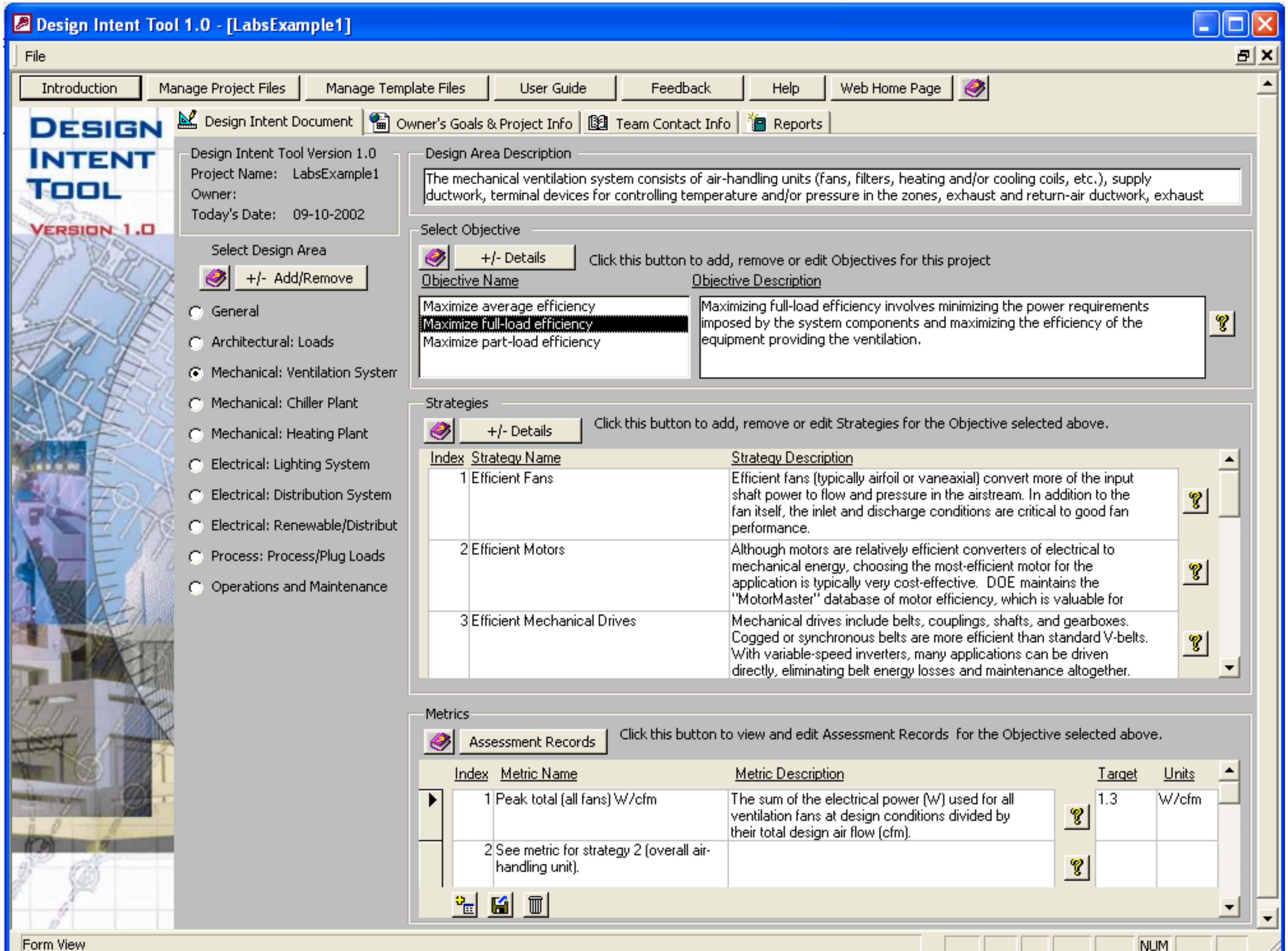


Design Intent Documentation Feeds into Building Life-Cycle Information System

BLISS Performance Tracking:



Design Intent Tool



Design Intent Tool Status

- Beta version completed
- 450 Copies distributed in October
- Available on CD or downloadable from web

Next Steps

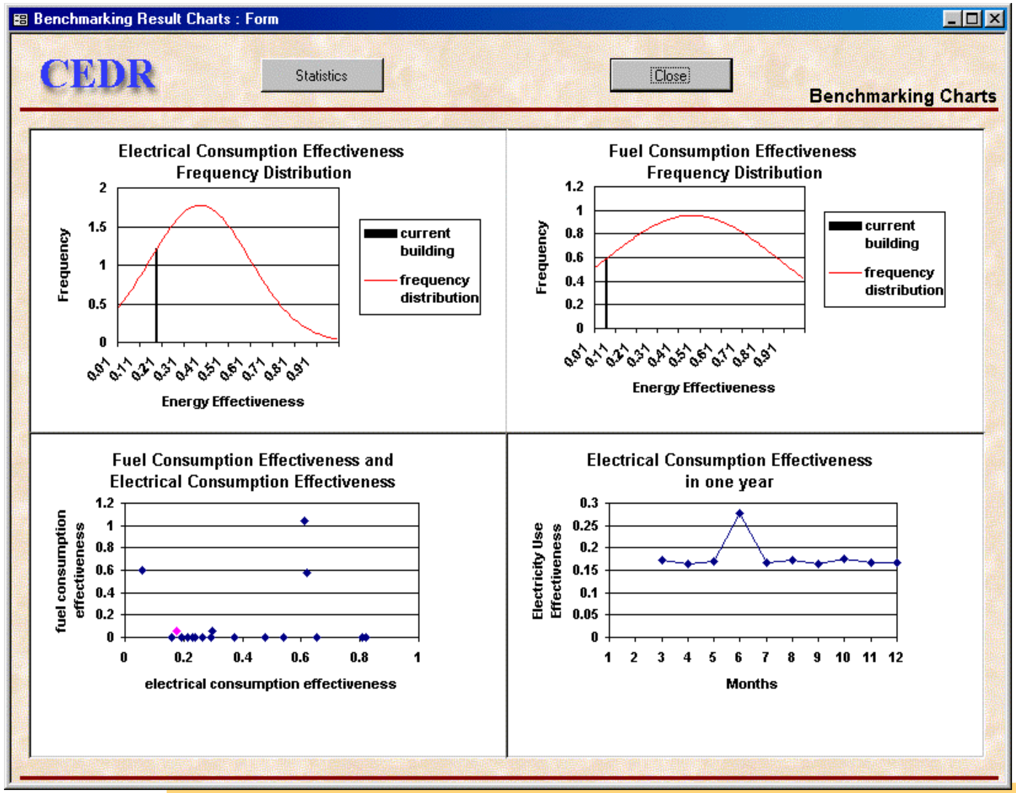
- Transfer to market (transformation)
- Testing and enhancements
- Training
- New templates for other building types

Benchmarking Protocol and Tools

Objective:

Provide feedback to designers and operators of actual building loads and performance (reduce oversizing)

- Performance Metrics
- Database
- Feedback Mechanisms



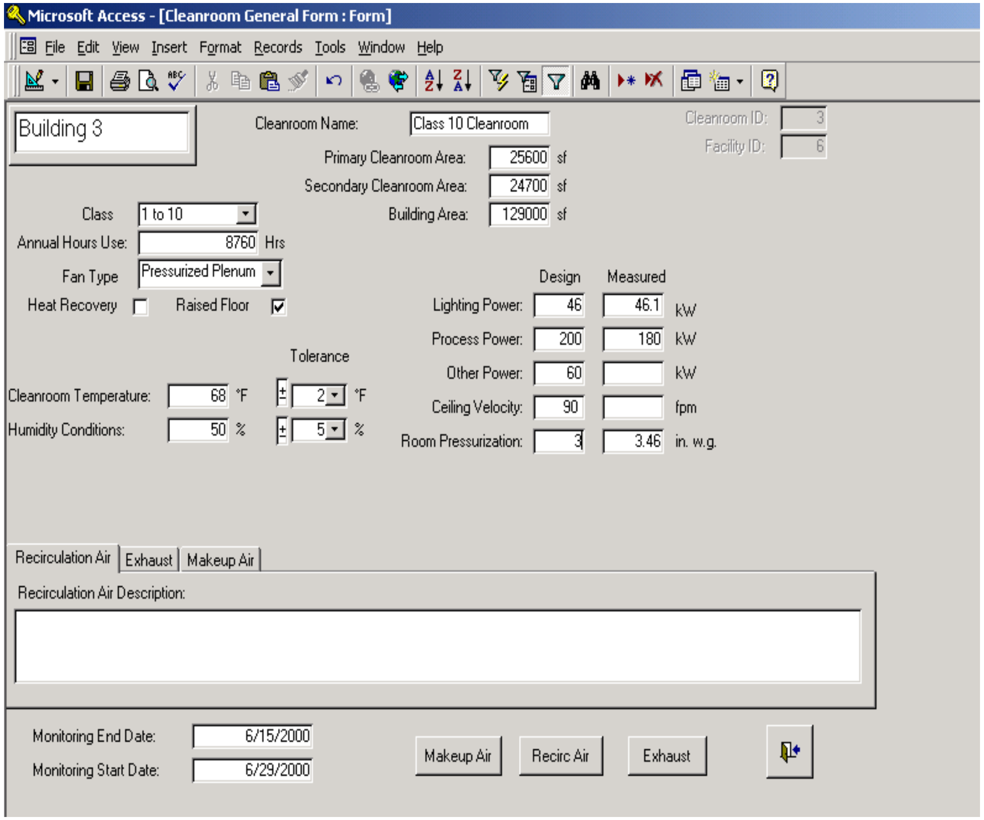
LABS FOR THE 21ST CENTURY

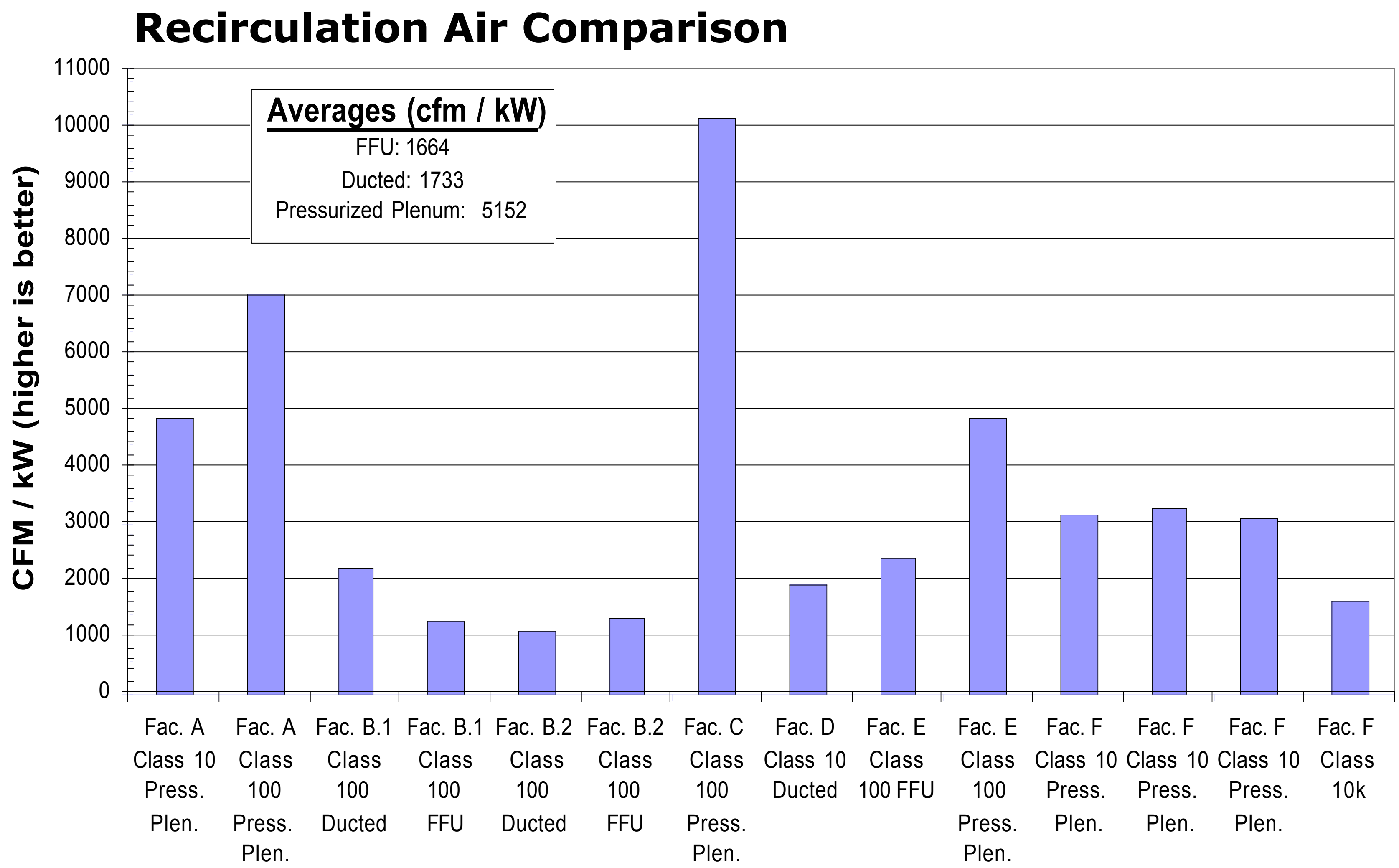
Laboratory Energy Performance Metrics

System	Annual EU Index	Other Key Metrics
Ventilation	kWh/sq.ft.	Peak total (all fans) W/cfm Average total cfm/peak cfm Peak lab-only exhaust cfm/nsf
Cooling Plant	kWh/sq.ft.	Peak W/sq.ft. Average kW/ton Peak tons/sq.ft.
Lighting	kWh/sq.ft.	Peak W/sq.ft.
Process/Plug	kWh/sq.ft.	Peak W/sq.ft.
Heating Plant	BTU/sq.ft.	
Total	kWh/sq.ft. (total electric) BTU/sq.ft. (combined gas and electric)	Annual peak W/sq.ft. Annual $/sq.ft. energy cost
Energy Effectiveness		100 x Idealized BTU/actual BTU

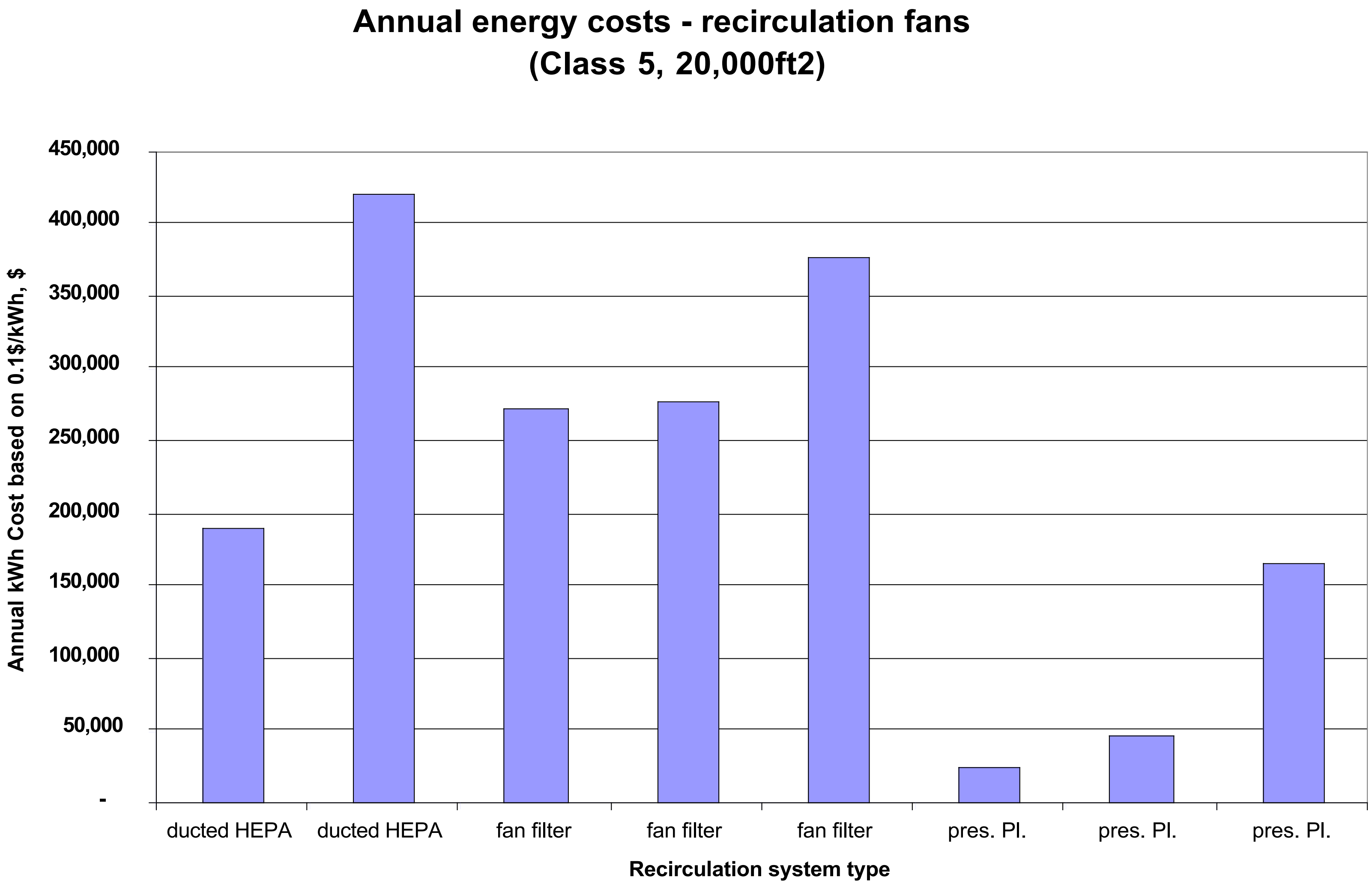
Benchmarking Can Help Establish Efficiency Goals

- Energy Budget
  - Total facility
  - End use
- Efficiency Targets for key systems/components
  - Cfm/KW
  - KW/ton
  - Pressure drop

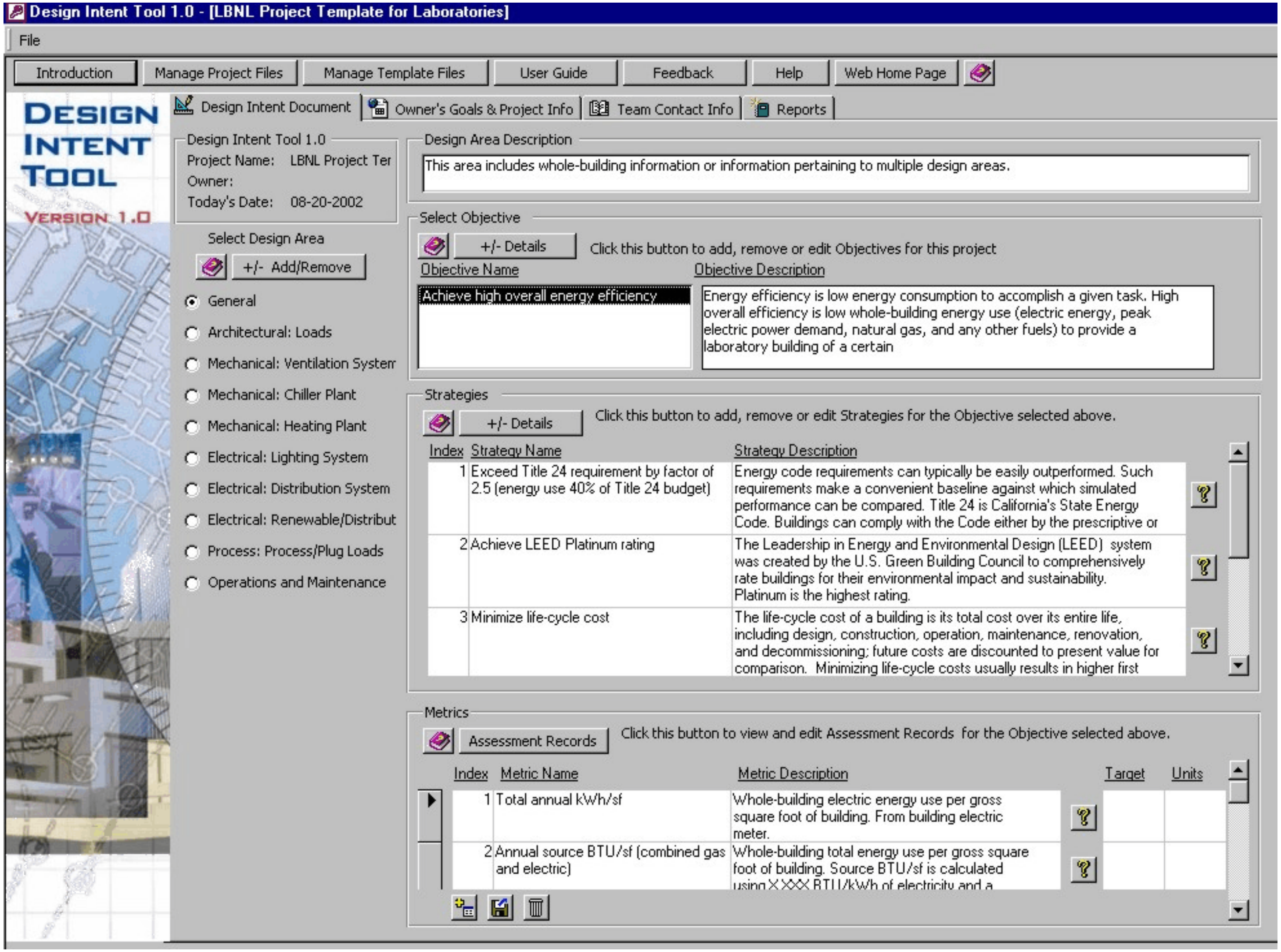



Recirculation Air Comparison
Averages (cfm / kW)
FFU: 1664
Ducted: 1733
Pressurized Plenum: 5152
CFM / kW (higher is better)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
Fac. A Class 10 Press. Plen.
Fac. A Class 100 Press. Plen.
Fac. B.1 Class 100 Ducted
Fac. B.1 Class 100 FFU
Fac. B.2 Class 100 Ducted
Fac. B.2 Class 100 FFU
Fac. C Class 100 Press. Plen.
Fac. D Class 10 Ducted
Fac. E Class 100 FFU
Fac. E Class 100 Press. Plen.
Fac. F Class 10 Press. Plen.
Fac. F Class 10 Press. Plen.
Fac. F Class 10 Press. Plen.
Fac. F Class 10k

What is the cost impact?



Design Intent Document



Benchmarking Status

- Metrics identified and tested
- First generation databases developed
- Small sample sizes yielding valuable information

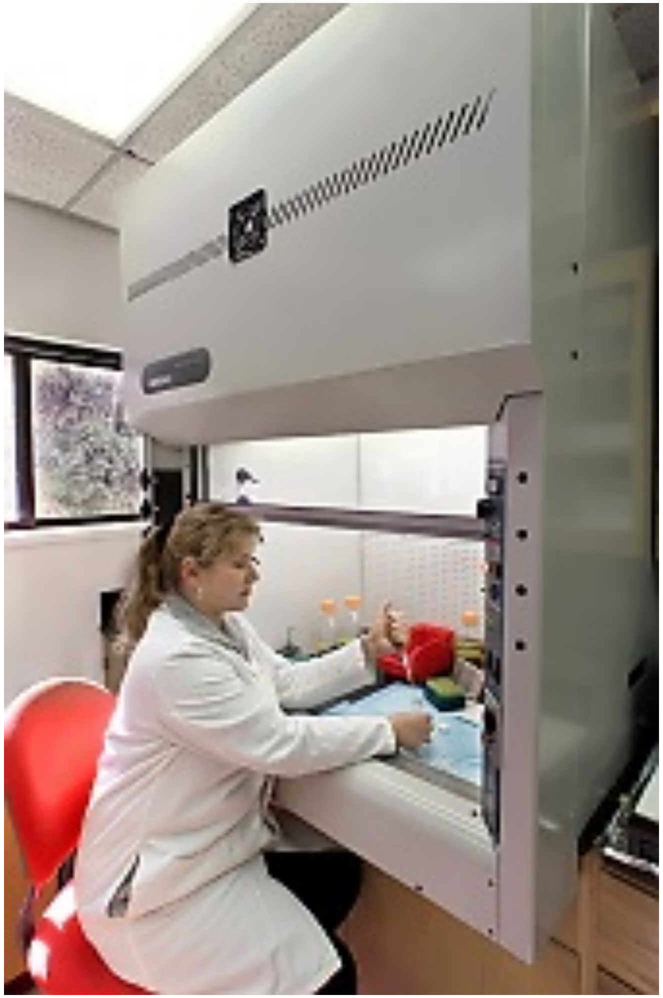
Next Steps

- Increase sample sizes
- Refine reporting
- Automate web based benchmarking tool(s)
- Develop model based benchmarking (EER)

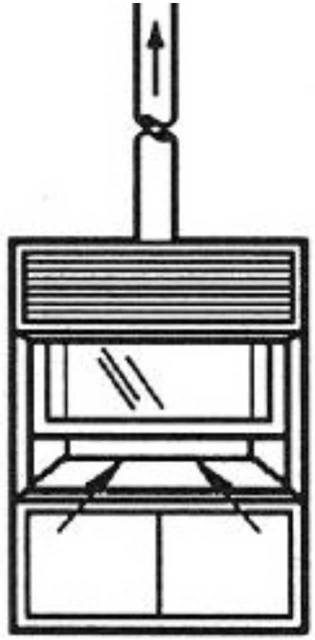
Fume Hood Containment - High Performance Hoods

Objective:

Reduce fume hood air flow requirements at least 50%



Standard Fume Hood Designs



Exhaust system induces airflow through hood.

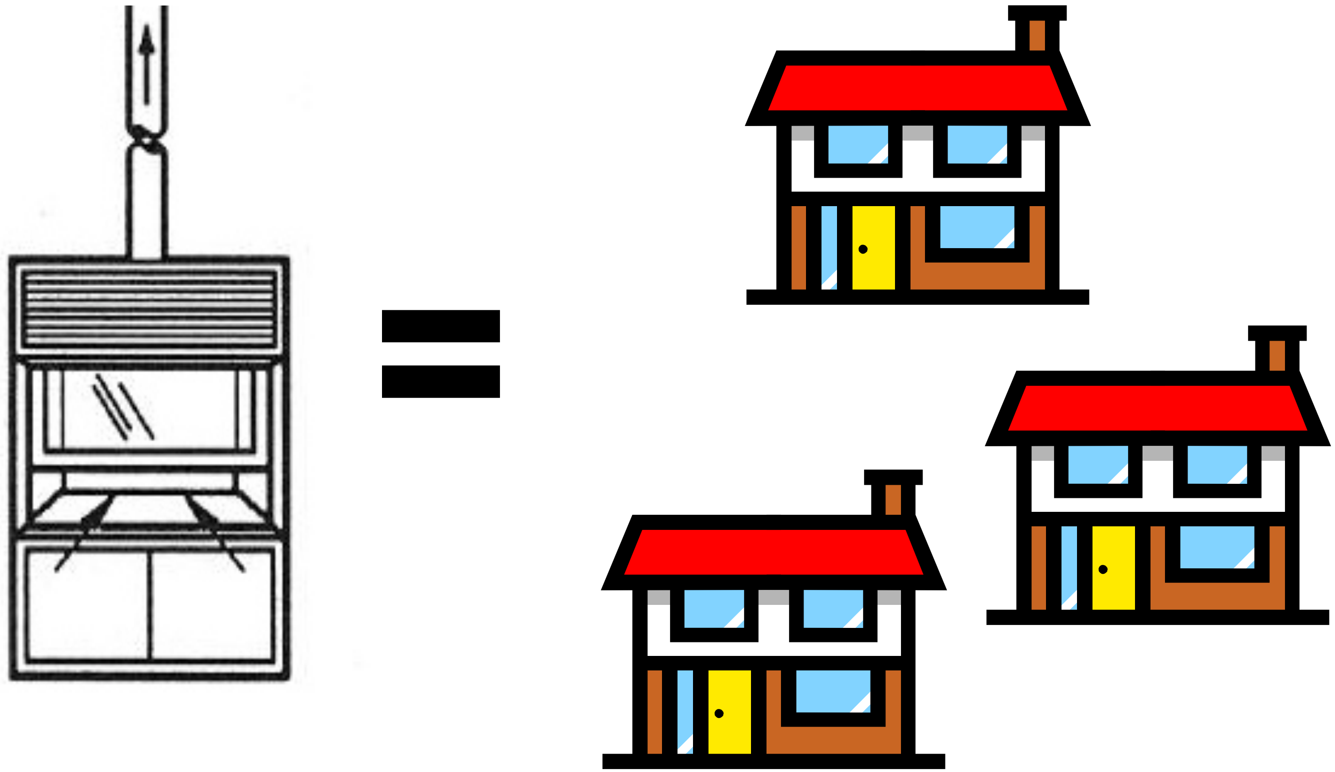
Airflow through hood's open sash is ~100 FPM

Supply air must "make up" combined hood exhaust

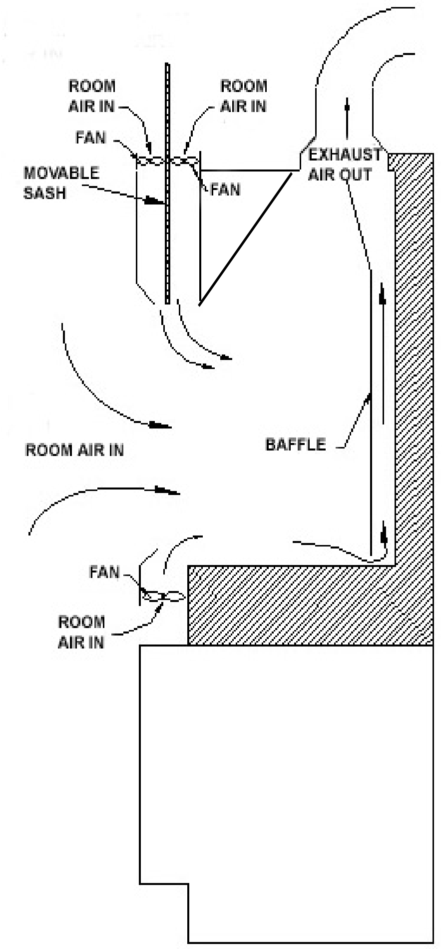
Consequently, large air volumes are conditioned and expelled from laboratories 24/7

Fume hoods *typically* "drive" system sizing

Fume Hood Energy Consumption



Air Divider Technique



(Sectional view)

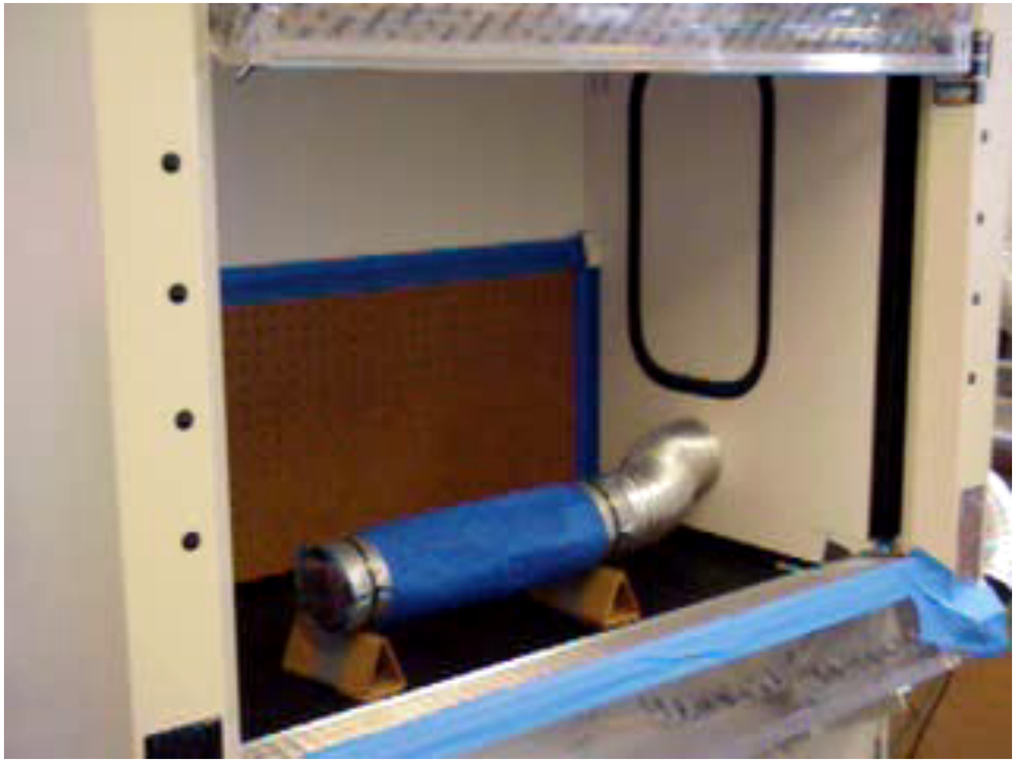
Low-turbulence Intensity

Displacement ventilation

Push-Pull Containment

U.S. Patent# 6,089,970

Smoke containment...



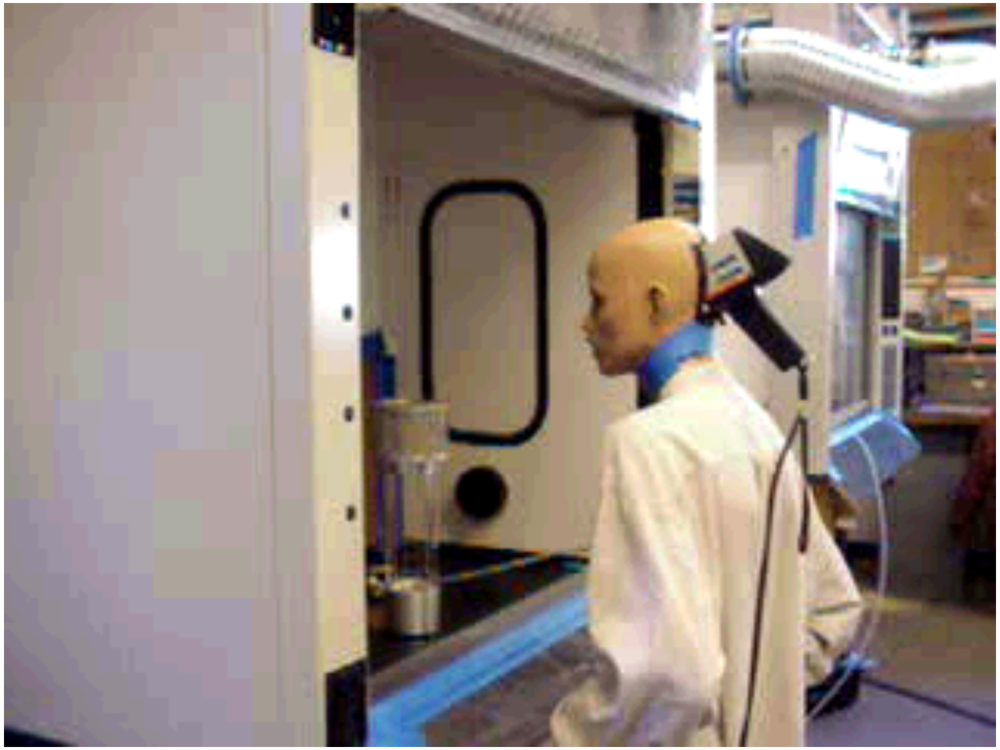
Smoke visualization test at 30% “normal” flow

Smoke in Supply Plenums…

Exhaust:
40% “normal” flow

Ejector:
8L/min.

Breathing Zone:
18 inches



Montana State University

Fisher-Hamilton alpha prototype Berkeley Hood.

Adapted standard Fisher-Hamilton hood

Installed Berkeley hood September 2000

Berkeley hood tested per ASHRAE 110

Passed standard ASHRAE 110 tests per ANSI Z9.5 recommendations

University of California, San Francisco

Researcher working at Berkeley hood.

Adapted standard Labconco hood

Installed Berkeley hood November 2000

Berkeley hood tested per ASHRAE 110

Passed standard ASHRAE 110 tests per ANSI Z9.5 recommendations

San Diego State University

Berkeley hood in testing and ready for shipping.

Adapted standard Labconco hood

Extensively tested hood per ASHRAE 110

Passed standard ASHRAE 110 tests per ANSI Z9.5 recommendations

Performed advanced challenges including cross drafts

Evaluated experimental tracer gas devices

Three experts and inventor contributed

LBNL supported by the following organizations:

California Energy Commission

U.S. Department of Energy

Montana State University

Pacific Gas and Electric

California Institute for Energy Efficiency

High Performance Fume Hood Status

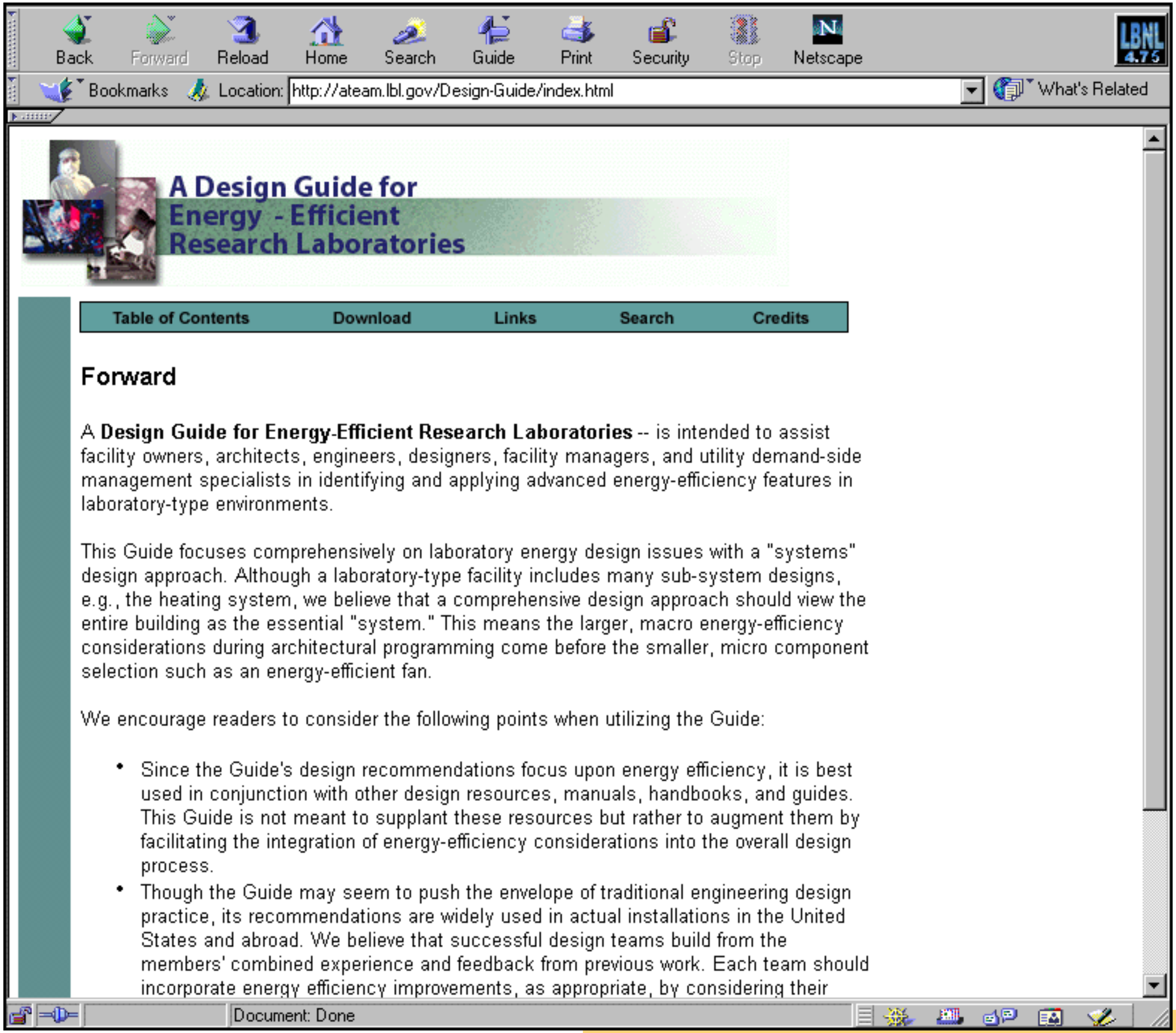
- Patents issued
- Partnering with hood and control manufacturers
- Field tests underway

Next Steps

- Scale up size
- Increase number of demonstrations
- Overcome institutional barriers
- Side-by-side testing

Laboratories for the 21st Century Design Tool Kit

- An Internet-accessible compendium containing the following tools:
  - Guides to energy efficient laboratory design.
  - Design intent tool.
  - (Future) national database with performance metrics for laboratory energy use.
  - Case studies.
  - Links to other related Web sites



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A Design Guide for Energy - Efficient Research Laboratories

Table of Contents | Download | Links | Search | Credits

Forward

A **Design Guide for Energy-Efficient Research Laboratories** -- is intended to assist facility owners, architects, engineers, designers, facility managers, and utility demand-side management specialists in identifying and applying advanced energy-efficiency features in laboratory-type environments.

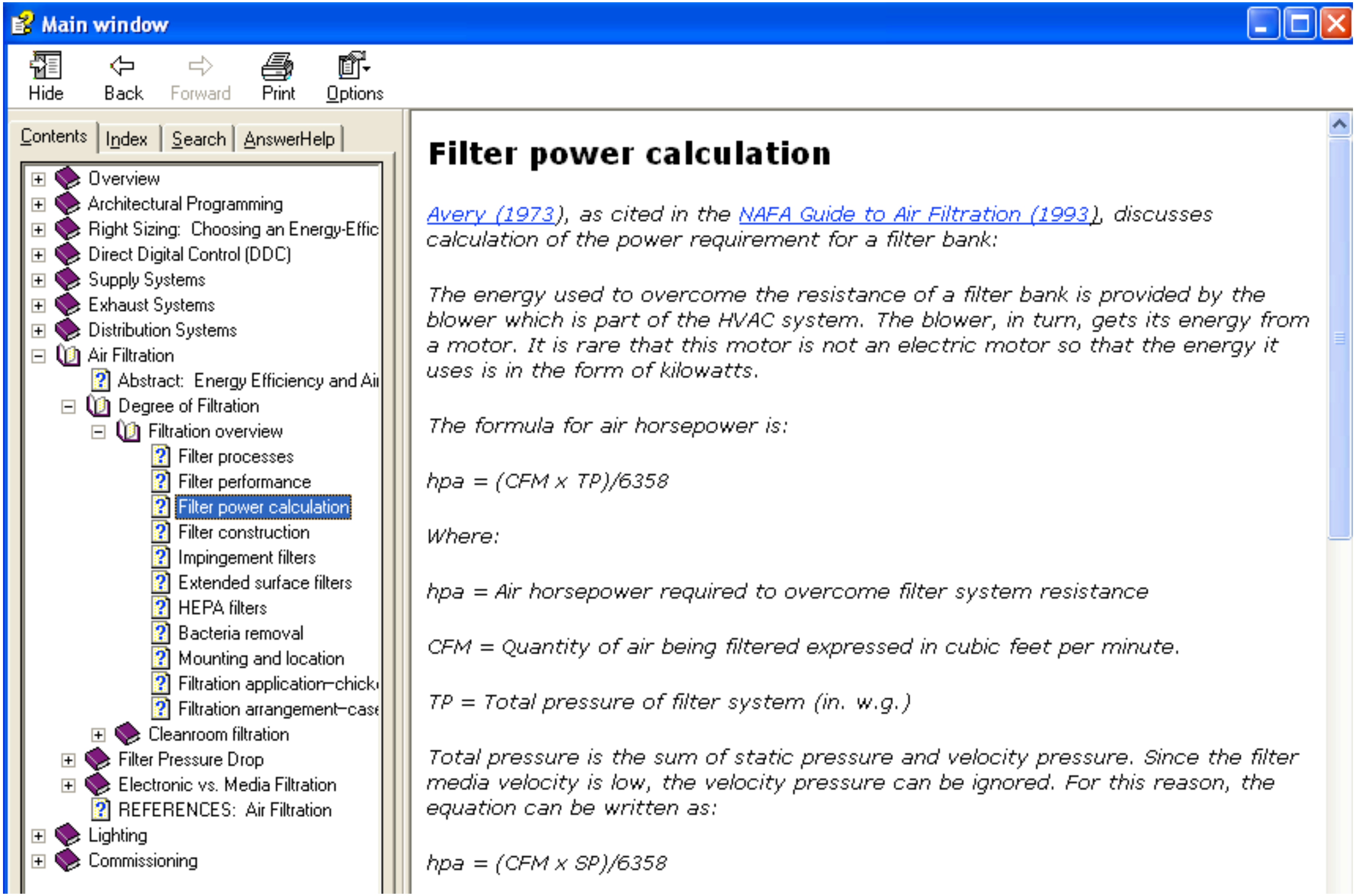
This Guide focuses comprehensively on laboratory energy design issues with a "systems" design approach. Although a laboratory-type facility includes many sub-system designs, e.g., the heating system, we believe that a comprehensive design approach should view the entire building as the essential "system." This means the larger, macro energy-efficiency considerations during architectural programming come before the smaller, micro component selection such as an energy-efficient fan.

We encourage readers to consider the following points when utilizing the Guide:

- Since the Guide's design recommendations focus upon energy efficiency, it is best used in conjunction with other design resources, manuals, handbooks, and guides. This Guide is not meant to supplant these resources but rather to augment them by facilitating the integration of energy-efficiency considerations into the overall design process.
- Though the Guide may seem to push the envelope of traditional engineering design practice, its recommendations are widely used in actual installations in the United States and abroad. We believe that successful design teams build from the members' combined experience and feedback from previous work. Each team should incorporate energy efficiency improvements, as appropriate, by considering their

Document: Done

Lab Design Guide – Reference Manual



Labs21 Tool Kit Status

- Design Guide and other tools available on web

Labs 21 ready to partner with States

- Training
  - Introductory workshop (existing)
  - Advanced hands on tool training
- Tool enhancement and development
- Demonstrations

Overcoming Institutional Barriers

- Energy is a controllable cost
- First cost bias

  …Buildings outlive process
- Outdated rules of thumb and common beliefs
- Codes and Standards

  …e.g. face velocity does not equal safety

Summary

Hi-Tech Industries are important

…growing economic driver in most (all?) states

Cleanrooms/Laboratories are energy intensive

…huge energy savings opportunities

An integrated R&D and MT approach is ideal